

## CLAIMS

1. A coding mode determining apparatus for determining at least one of a plurality of candidate coding modes of an image block,  
5 comprising:

a simple motion estimation portion that derives a coding cost of each of the coding modes, based on a simple motion estimation for small blocks, which are partitions of an image block that are obtained with each of the coding modes;

10 a coding mode selecting portion that selects a subset of the plurality of the coding modes, based on the coding costs derived by the simple motion estimation portion;

a complex motion estimation portion that derives a coding cost of each of the coding modes, based on a complex motion estimation for the  
15 small blocks obtained with at least a subset of said subset of coding modes; and

a coding mode determining portion that determines a coding mode of the image block, based on the coding costs derived by the complex motion estimation portion.

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2. The coding mode determining apparatus according to claim 1,  
wherein, when deriving a coding cost of each of the coding modes, the simple motion estimation portion performs a simple motion estimation in a plurality of picture reference directions on each of the  
25 small blocks obtained with each of the coding modes to calculate a coding cost, then selects a picture reference direction having the lowest coding cost for each individual small block, then sums up the coding costs of all of the small blocks relating to the selected picture reference directions for each of candidate division methods individually to derive a coding

cost of the coding mode of each of the candidate division methods.

3. The coding mode determining apparatus according to claim 1,  
wherein, when deriving a coding cost of each of the coding modes,  
5 the simple motion estimation portion performs a simple motion  
estimation in a plurality of picture reference directions on each of the  
small blocks obtained with each of the coding modes to calculate a coding  
cost, then converts the coding cost of each of the small blocks for each  
picture reference direction individually into a coding cost per image  
10 block to derive a coding cost of the coding mode of each of candidate  
division methods for each of the reference directions.

4. The coding mode determining apparatus according to claim 2 or  
3,  
15 wherein the simple motion estimation in a plurality of picture  
reference directions in the simple motion estimation portion includes  
only forward prediction in which a temporally preceding picture is  
referenced, and backward prediction in which a temporally following  
picture is referenced.

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5. The coding mode determining apparatus according to claim 2 or  
3,  
wherein the simple motion estimation in a plurality of picture  
reference directions in the simple motion estimation portion includes  
25 forward prediction in which a temporally preceding picture is referenced,  
backward prediction in which a temporally following picture is  
referenced, and bi-directional prediction in which pictures that are on  
both sides in time are referenced.

6. The coding mode determining apparatus according to claim 2 or 3,

wherein the simple motion estimation in a plurality of picture reference directions in the simple motion estimation portion includes  
5 forward prediction in which a temporally preceding picture is referenced, and backward prediction in which a temporally following picture is referenced, and

wherein the simple motion estimation portion derives a coding cost where bi-directional prediction in which pictures that are on both  
10 sides in time are referenced is performed, based on the forward prediction and the backward prediction.

7. The coding mode determining apparatus according to any of claims 1 to 6,

15 wherein the complex motion estimation portion determines a picture reference direction in the complex motion estimation, based on the simple motion estimation in the simple motion estimation portion.

8. The coding mode determining apparatus according to claim 7,

20 wherein, as a result of the simple motion estimation for the small blocks in the simple motion estimation portion, the complex motion estimation portion selects both the forward prediction and the backward prediction when their coding costs are substantially the same, and selects one of the prediction that has the smaller coding cost when their  
25 coding costs are different.

9. The coding mode determining apparatus according to any of claims 1 to 8,

wherein the complex motion estimation portion selects at least a

further subset of said subset of coding modes, based on the simple motion estimation for the small blocks in the simple motion estimation portion.

5    10.    The coding mode determining apparatus according to claim 9,  
         wherein the complex motion estimation portion selects each of the  
coding modes in ascending order of their coding costs, and terminates the  
selection immediately before the sum of the coding costs of the selected  
coding modes exceeds a margin for the processing amount.

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11.    The coding mode determining apparatus according to any of  
claims 1 to 10,

         wherein the simple motion estimation portion or the complex  
motion estimation portion changes a method of motion estimation in the  
15    simple motion estimation or the complex motion estimation in such a  
manner that a processing amount for the motion estimation process is  
maintained substantially constant.

12.    The coding mode determining apparatus according to any of  
20    claims 1 to 11,

         wherein the simple motion estimation is motion estimation with  
integer pixel accuracy, and

         wherein the complex motion estimation is motion estimation with  
non-integer pixel accuracy.

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13.    An integrated circuit comprising the coding mode determining  
apparatus according to any of claims 1 to 12.

14.    An image coding apparatus comprising:

the coding mode determining apparatus according to any of claims 1 to 12; and

a coding apparatus that codes an image block, based on a coding mode of the image block that is determined by the coding mode determining apparatus.

15. An integrated circuit comprising the image coding apparatus according to claim 14.

10 16. A coding mode determining apparatus for determining a coding mode of an image block, comprising:

an inter prediction portion that performs inter prediction on each block of field structure blocks and frame structure blocks of the image block to derive a coding cost;

15 a coding picture structure determining portion that determines a coding picture structure of the image block, based on the coding costs obtained by the inter prediction portion;

an intra prediction portion that performs intra prediction on each of the blocks having the determined coding picture structure to derive a coding cost; and

20 a coding prediction method determining portion that determines a coding prediction method for each of the blocks of the image block that have the determined coding picture structure by comparing the coding costs obtained with the inter prediction and the coding costs obtained with the intra prediction.

17. The coding mode determining apparatus according to claim 16, wherein the inter prediction portion sums up the respective coding costs of the blocks of the frame structure blocks to derive a coding

cost of the frame structure blocks, and sums up the respective coding costs of the blocks of the field structure blocks to derive a coding cost of the field structure blocks.

5 18. The coding mode determining apparatus according to claim 17, wherein the intra prediction portion performs intra prediction on each of the blocks having the determined coding picture structure to derive a coding cost, and

10 wherein the coding prediction method determining portion compares the coding costs derived in the inter prediction portion and the coding costs derived in the intra prediction portion for each of the blocks having the determined coding picture structure to determine a coding prediction method for each of the blocks.

15 19. The coding mode determining apparatus according to any of claims 16 to 18,

wherein the image block is a block pair consisting of two square blocks.

20 20. An integrated circuit comprising the coding mode determining apparatus according to any of claims 16 to 19.

21. An image coding apparatus comprising:

25 the coding mode determining apparatus according to any of claims 16 to 19; and

a coding apparatus that codes an image block based on a coding mode of the image block that is determined by the coding mode determining apparatus.

22. An integrated circuit comprising the image coding apparatus according to claim 21.
23. A coding mode determining apparatus for determining a coding  
5 mode of an image block, comprising:  
a simple motion estimation portion that performs a simple motion estimation for each block of field structure blocks and frame structure blocks of the image block to derive a coding cost; and  
a coding picture structure determining portion that determines a  
10 coding picture structure by comparing the coding costs of the field structure blocks and the frame structure blocks of the image block, based on the coding costs obtained by the simple motion estimation portion.
24. The coding mode determining apparatus according to claim 23,  
15 wherein the simple motion estimation portion performs simple inter prediction and simple intra prediction on each of the blocks, then selects one of the simple inter prediction and the simple intra prediction for each of the blocks by comparing the coding costs of the simple inter prediction and the coding costs of the simple intra prediction, and  
20 further sums up the respective coding costs of the blocks for each of the picture structures to derive a coding cost of the frame structure blocks and a coding cost of the field structure blocks.
25. The coding mode determining apparatus according to claim 24,  
25 wherein the simple inter prediction is inter prediction with integer pixel accuracy.
26. The coding mode determining apparatus according to any of claims 23 to 25,

wherein the image block is a block pair consisting of two square blocks.

27. An integrated circuit comprising the coding mode determining  
5 apparatus according to any of claims 23 to 26.

28. An image coding apparatus comprising:  
the coding mode determining apparatus according to any of  
claims 23 to 26;  
10 a complex motion estimation portion that performs a complex  
motion estimation for an image block having a coding picture structure  
determined by the coding mode determining apparatus; and  
a coding portion that codes the image block based on a prediction  
result obtained by the complex motion estimation portion.

15 29. The image coding apparatus according to claim 28,  
wherein the complex motion estimation portion performs complex  
inter prediction or complex intra prediction on each block having the  
determined coding picture structure.

20 30. The image coding apparatus according to claim 29,  
wherein the complex inter prediction is inter prediction with  
non-integer pixel accuracy.

25 31. An integrated circuit comprising the image coding apparatus  
according to any of claims 28 to 30.

32. A coding mode determining method for determining at least one  
of a plurality of candidate coding modes of an image block, comprising:



a simple motion estimation step of deriving a coding cost of each of the coding modes, based on a simple motion estimation for small blocks, which are partitions of an image block that are obtained with each of the coding modes;

5        a coding mode selecting step of selecting a subset of the plurality of the coding modes, based on the coding costs derived by the simple motion estimation step;

         a complex motion estimation step of deriving a coding cost of each of the coding modes, based on a complex motion estimation for the small  
10 blocks obtained with at least a subset of said subset of coding modes; and

         a coding mode determining step of determining a coding mode of the image block, based on the coding costs derived by the complex motion estimation step.

15 33. A coding mode determining method for determining a coding mode of an image block, comprising:

         an inter prediction step of performing inter prediction on each block of field structure blocks and frame structure blocks of the image block to derive a coding cost;

20        a coding picture structure determining step of determining a coding picture structure of the image block based on the coding costs obtained by the inter prediction step;

         an intra prediction step of performing intra prediction on each of the blocks having the determined coding picture structure to derive a  
25 coding cost; and

         a coding prediction method determining step of determining a coding prediction method for each of the blocks of the image block that have the determined coding picture structure by comparing the coding costs obtained with the inter prediction and the coding costs obtained

with the intra prediction.

34. A coding mode determining method for determining a coding mode of an image block, comprising:

5 a simple motion estimation step of performing a simple motion estimation for each block of field structure blocks and frame structure blocks of the image block to derive a coding cost; and

a coding picture structure determining step of determining a coding picture structure by comparing the coding costs of the field  
10 structure blocks and the frame structure blocks of the image block, based on the coding costs obtained by the simple motion estimation step.

35. A coding mode determining program for determining, with a computer, at least one of a plurality of candidate coding modes of an  
15 image block,

wherein the coding mode determining program lets the computer perform a coding mode determining method comprising:

a simple motion estimation step of deriving a coding cost of each of the coding modes, based on a simple motion estimation for small  
20 blocks, which are partitions of an image block that are obtained with each of the coding modes;

a coding mode selecting step of selecting a subset of the plurality of the coding modes, based on the coding costs derived by the simple motion estimation step;

25 a complex motion estimation step of deriving a coding cost of each of the coding modes, based on a complex motion estimation for the small blocks obtained with at least a subset of said subset of coding modes; and

a coding mode determining step of determining a coding mode of the image block, based on the coding costs derived by the complex motion

estimation step.

36. A coding mode determining program for determining, with a computer, a coding mode of an image block,

5 wherein the coding mode determining program lets the computer perform a coding mode determining method comprising:

an inter prediction step of performing inter prediction on each block of field structure blocks and frame structure blocks of the image block to derive a coding cost;

10 a coding picture structure determining step of determining a coding picture structure of the image block based on the coding costs obtained by the inter prediction step;

an intra prediction step of performing intra prediction on each of the blocks having the determined coding picture structure to derive a coding cost; and

15 a coding prediction method determining step of determining a coding prediction method for each of the blocks of the image block that have the determined coding picture structure by comparing the coding costs obtained with the inter prediction and the coding costs obtained with the intra prediction.

37. A coding mode determining program for determining, with a computer, a coding mode of an image block,

25 wherein the coding mode determining program lets the computer perform a coding mode determining method comprising:

a simple motion estimation step of performing a simple motion estimation for each block of field structure blocks and frame structure blocks of the image block to derive a coding cost; and

a coding picture structure determining step of determining a

coding picture structure by comparing the coding costs of the field structure blocks and the frame structure blocks of the image block, based on the coding costs obtained by the simple motion estimation step.